

WHAT IS CLAIMED IS:

1. A valve-driving system which is applied to an internal combustion engine having a plurality of cylinders for driving an intake or exhaust valve provided in each cylinder, comprising:

a plurality of valve-driving apparatuses, each of which is provided for at least each one of the intake valve and the exhaust valve, each valve-driving apparatus comprising an electrical motor as a driving source for generating rotation motion and a power transmission mechanism provided with a transmitting section for transmitting the rotation motion generated by the electrical motor and a converting section for converting the rotation motion transmitted from the transmitting section into opening and closing motion of the valve to be driven; and

a motor control device which controls operations of electric motors of the respective valve-driving apparatuses in accordance with the operation state of the internal combustion engine.

2. The valve-driving system according to claim 1, wherein the motor control device controls the operation of the electric motor in accordance with the operation state of the internal combustion engine such as to change operation characteristics of at least one of an operation angle, lift characteristics and a maximum lift amount of the valve to be driven.

3. The valve-driving system according to claim 1, wherein

the converting section of the power transmission mechanism converts the rotation motion generated by the electric motor into the opening and closing motion utilizing a cam.

4. The valve-driving system according to claim 3, wherein the motor control device sets a control amount of the electric motor while taking, into account, the variation of friction torque which acts on rotation of the cam.

5. The valve-driving system according to claim 3, wherein the motor control device sets the control amount of the electric motor while taking, into account, a control state concerning intake or exhaust characteristics of the internal combustion engine.

6. The valve-driving system according to claim 5, wherein the motor control device corrects the control amount of the motor such that an air fuel ratio is controlled to a predetermined target value while taking, into account, a control state concerning the air fuel ratio as the characteristics of the internal combustion engine.

7. The valve-driving system according to claim 5, further comprising an abnormality judging device which judges whether the valve-driving system is abnormal based on a correction amount with respect to the control amount of the electric motor, the correction amount being provided by the consideration of the

control state concerning intake or exhaust characteristics of the internal combustion engine.

8. The valve-driving system according to claim 3, wherein the motor control device estimates variation of the number of revolution of the internal combustion engine based on variation in the operation state of the internal combustion engine, and sets a control amount of the electric motor while taking the result of the estimation into account.

9. The valve-driving system according to claim 3, wherein when a friction torque acting on the rotation of the cam assumes a negative value, the electric motor is capable of being driven by rotation motion of the cam to generate electricity.

10. The valve-driving system according to claim 3, wherein a motor rotation position detecting device which detects a rotation position of the electric motor is added to the electric motor, and the motor control device includes a cam position specifying device which specifies a rotation position of the cam based on the detection result of the rotation position of the electric motor.

11. The valve-driving system according to claim 10, wherein when a speed reducing ratio between the electric motor and the cam is defined as $N:M$ (wherein, $N > M$, and N and M are integers having no common divisors except 1), N is set to 6 or lower.

12. The valve-driving system according to claim 3, wherein the motor control device includes an initializing device which makes the electric motor rotate in accordance with a predetermined condition when the internal combustion engine is in a predetermined state, and which grasps a rotation position of the cam based on variation in driving state of the electric motor which appears in connection with variation in friction torque of the cam while rotating.

13. The valve-driving system according to claim 12, wherein the initializing device rotates the electric motor when the internal combustion engine is stopped to grasp the rotation position of the cam, and makes a storing device, which can store information also during a stop time period of the internal combustion engine, store therein information indicative of the grasped rotation position of the cam, and the motor control device specifies the rotation position of the cam based on the information stored in the storing device when the internal combustion engine is started next time, and starts controlling the electric motor.

14. The valve-driving system according to claim 3, wherein the motor control device includes a valve rotation executing device which drives the electric motor such that the valve rotates around an axial direction thereof in a predetermined time period during stoppage of the internal combustion engine.

15. The valve-driving system according to claim 3, wherein the motor control device includes a lift amount control device which normally and reversely drives the electric motor such that the lift amount of the valve is limited to a predetermined value which is smaller than a maximum lift amount which can be obtained when the cam is rotated through one revolution.

16. The valve-driving system according to claim 3, wherein the motor control device includes a mode switching device which switches driving modes of the electric motor between a normal rotation mode in which the electric motor is driven only in the normal direction and a normal-reverse rotation mode in which the electric motor is normally or reversely rotated in accordance with the operation state of the internal combustion engine.

17. A valve-driving apparatus of an internal combustion engine, comprising:

- an electric motor as a driving source for generating rotation motion;

- a power transmission mechanism provided with a transmitting section for transmitting the rotation motion generated by the electrical motor and a converting section for converting the rotation motion transmitted from the transmitting section into opening and closing motion of the valve to be driven;
- and

- a motor control device which controls operation of the electric motor such that operation characteristics of at least

one of an operation angle, a lift characteristics and a maximum lift amount of the valve to be driven is changed in accordance with the operation state of the internal combustion engine.